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VI

TERTIARY DEPOSITS OF NORTHEASTERN MEXICO

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INTRODUCTION

In connection with the examination of the artesian water conditions of Northeastern Mexico, and the search for oil deposits in the same region, a considerable amount of geological investigation has been necessary. The field work with which the writer has been directly connected was carried on principally by Prof. W. F. Cummins, assisted by Mr. J. M. Sands. Mr. W. Kennedy also spent some time on more detailed work along the Rio Grande and in making special sections. In order that the information thus obtained may be of service to other workers in this same field, the following generalized statement has been prepared from their various reports and collections and from personal knowledge of the deposits.

It must be remembered that the work has largely been of the nature of a reconnaissance and that it has been done with a total lack of topographic maps and in part even without those giving accurate geographic detail, since these were not available until after the field work was completed. It is also to be regretted that while large collections of fossils were made during the progress of the work, only a small part of these were accessible for use in preparation of the present paper.

THE AREA

Lying to the east of that portion of the main body of the mountainous highlands or Cordilleras of Mexico known as the Sierra Madre Oriental, which, beginning at the Sierra Carmen on the Rio Grande border, extends southeastwardly by way of Monterey and Tamasopa, there is a broad valley, interrupted in many parts by hills. This valley in turn is bordered on the east by disconnected ranges and groups of hills, which, as a whole, are roughly parallel to the main range and to the course of the Rio Grande. Among these groups and ranges may be named the San Antonio, San Juan, Vallecillo, Picachos, Papagallos, San Carlos and Tamaulipas. Prof. Cummins has proposed that these be known collectively as the Tamaulipas Range, which is seemingly warranted by the common origin of the groups.

This range consists of deposits of shales and limestones of late Cretaceous age, more or less altered and disturbed by igneous activity and by folding, and as the trend of the coast in this region is a little west of south, the southeast course of the Tamaulipas Range brings it rapidly nearer the Gulf until, in the region around Tordo Bay, fifty miles north of Tampico, the hills of this range are within ten miles of the coast and scattered peaks and ridges of later eruptives occur within four miles or less of the Gulf shore.

In the triangle thus formed by the Rio Grande, the Tamaulipas Range and the coast line we find the occurrence of Tertiary deposits which are the direct continuation of those of the Texas area, but the Tertiary beds, which, along the Rio Grande, form the surface rocks for a distance of 150 miles, narrow rapidly toward the south, the lower beds disappearing in turn by reason of successive overlaps of the later, until, at the southern end, on the Zarzizal River, just north of Tordo Bay, the entire exposure shows no Tertiary beds below the Oligocene, which has here a width of a very few miles.

The Tamaulipas Range thus marks the extreme western and southern limits of these beds and, so far as our investigations go, this area contains the last appearance in Mexico of the Eocene beds as known in Texas, since the beds of this age which are found south of the Tamaulipas Range have a fauna more nearly related to those of the deposits of the Pacific Coast.

PHYSIOGRAPHY

The structure of this coastal area is largely that of a monoclinal plain with local foldings which are, however, of very slight extent, except in close proximity to the western boundary. Within it there are comparatively few exposures of igneous rocks and these are confined to its southern portion, and, as a whole, it corresponds closely in its topographic features with the southwestern Texas region. The gentle slope of the land immediately adjacent to the Gulf shore, which has such a broad development in the Texas coast prairies, here rapidly narrows toward the south. In the more elevated region directly west of it are exposed the calcareous materials and conglomerates which were first described from Reynosa on the Rio Grande and named for that place. These beds, which may be correlated with the Lafayette formation of the Pliocene, not only form the surface rocks of the area lying east of that in which the lower Tertiaries are now exposed, but judging from the numerous residuals occurring over the entire area and even in the Tamaulipas Range itself, seem, when originally laid down, to have formed a mantle over it all. Indeed, this formation, either by its actual presence or by the wide distribution of the detritus from it in the territory from which it has been denuded, masks and covers the underlying beds to such an extent as to render it difficult, if not impossible at many places, to determine their age or even their character.

Taken as a whole, the area occupied by the lower Tertiaries is one of rather low relief as compared with the territory west of it and hills of any considerable height above the general level of the country are rather few and principally confined to the western portion. They are practically all the result of erosive action. In the northwestern portion of the area there are long ranges of these hills extending from Amole Creek to the Salado River which are known as the Ceja del Macha and Ceja Madre and are made up of clays and hard Tertiary sandstones. To the south similar but lesser ranges and isolated hills occur which owe their existence to other sandstones and clays of the same or later horizons. To this class also belong the hills east of Cerralvo, the Sierra Colorado northeast of Ramones, Loma Alta and

Sierra Larga in the valley of the Salinas River near Hererras, and other similar hills along the western margin of the area as far south as the Conchos River.

The Sierra de Pomeranes, east of Mendez on the Conchos, while composed principally of sediments of middle or upper Eocene age and largely due to erosive action, seem to be connected also with the Corcovado uplift and mark the beginning of the influence of such orogenic movements. These become more and more manifest toward the south as shown in the Martines hills east of Abasolo and in the San Jose de las Rusias hills, where igneous rocks make their appearance breaking through the sediments of the upper Oligocene. The northern half of the area is drained by affluents of the Rio Grande. The most northerly streams of interest are the arroyos de Caballero and del Amole, a few miles south of Guerero. Following these the Salado River, which drains the Sabinas and Esperanza coal fields, crosses this belt and empties into the Rio Grande opposite Zapata. The principal branch of this river on the south is the Sabinas. South of these, the Salinas River (also called the Pesqueria) coming in from the region just north of Monterey, joins the San Juan near Aldamos. The San Juan itself, which drains the area south of Monterey, flows northeastward and reaches the Rio Grande at Carmargo. South of the Rio Grande the only two important river systems are the Conchos and the Soto la Marina. The Conchos heads west of Linares and, flowing north of the San Carlos and Burgos groups of mountains, reaches the gulf by way of Mendez and San Fernando, while the Soto la Marina, rising just southward of Linares, flows southeastward by way of Abasola and Soto la Marina, passes between the Sierras de Martines and Tamaulipas and then turns eastward to the gulf. In its lower reaches the Conchos River is sometimes called the Presas. Between these two rivers is the arroyo Chorreras and south of them the Zarzizal, which empties into Tordo Bay.

CRETACEOUS FLOOR

The deposits of Cretaceous age which appear in this area in connection with the Tertiary are: The Escondido Beds, the Papagallos Shales and the San Juan Limestones.

ESCONDIDO BEDS

These beds as described from the Rio Grande section¹ comprise the materials lying between the top of the Coal Series (that division of the Taylor marls which contains the coal deposits of Eagle Pass, Fuente, Sabinas, Esperanza, etc.), and the basal Tertiary and consist of alterations of clays and sands, more or less glauconitic, with an abundant and characteristic fauna, which is as yet only partially described. *Sphenodiscus pleurisepta* Con., and *Ostrea cortex* Con., are probably the most abundant species in it, although it also carries a large gasteropod fauna, including *Buccinopsis parryi* Con., *Volutomorpha texana* Con.

On the Rio Grande the rocks of this formation extend from Eagle Pass to the mouth of Caballero Creek, where we found its contact with the Midway, or basal Eocene. This contact was traced southward as far as the Rancho del Pescado, a few miles southwest of the Laguna de la Leche, where we found the last exposure of the clays with *Ostrea cortex*. It is probable that the brown clays and shales occurring on the Salado River and tributaries north of Rodriguez, may belong to the Escondido, but we found no fossils that would enable us to place them there with certainty, nor were we able to recognize them farther south.

The Escondido is the latest Cretaceous known in the Texas area. In its lower part it carries *Exogyra costata*, but this is absent from its upper beds. Stephenson says of it:²

"In this connection it should be stated that the Rancocas and Manasquan formations of New Jersey, which carry only a meager fauna, are thought to be somewhat younger than the *Exogyra costata* zone, and the upper part of the Escondido formation of southwestern Texas may be a little younger

¹ Dumble, E. T., Notes of the Geology of the Valley of the Middle Rio Grande, Bull. Geol. Soc. of A., Vol. 3, p. 227, 1892.

² Stephenson, L. W., "Cretaceous-Eocene Contact," U. S. G. S. Prof. Paper 90-J, p. 157, 1915.

than that zone, although its fauna is composed of strictly Mesozoic types, of which the genus *Sphenodiscus* is the most striking example."

PAPAGALLOS SHALE

To the west of the final exposure of the Escondido beds near the Pescado Ranch and apparently dipping under them, there is a series of very fine-grained blue or black limy clay shales, weathering brown, yellow or white, in which we have so far found no fossils. These shales carry both selenite and barite and weather into slaty particles. These shales were first studied by us in the Papagallos Hills west of Ramones and we have given them this name. The Papagallos shales are exposed along the western border of this area from the San Antonio Range, on the north, nearly to Tordo Bay and are also found over extensive areas south and west of the Tamaulipas Range. They overlie the gray limestone of the San Juan and have a very considerable thickness.

SAN JUAN LIMESTONE

Exposures in various canyons of the Tamaulipas Range show, underlying the Papagallos shales, a series of thin to medium bedded gray limestones with *Inocerami* and *Ammonites*. The fossils so far found are not very well preserved, but the *Ammonites* seem to fix the age as equivalent to the Taylor or Austin beds of the Texas Cretaceous. In a few places the Tertiary beds overlap the Papagallos and rest directly upon these limestones.

South and west of the Tamaulipas Range the Papagallos shales and San Juan limestones occupy a very large area, overlie the Tamasopa limestone, which is the top of the Middle Cretaceous, and represent the entire series of Upper Cretaceous beds of the Mexican geologists as known here.

The exact correlation of these beds with those of the Texas section is not yet possible, as they represent an entirely different phase of deposition and carry so few fossils.

The upper Tamasopa limestone around Micos is correlated by Bose³ with the Woodbine or Timber Creek beds of the Upper Cretaceous of Texas, which is probably of the same age as the Dakota of the interior region.

³ Bose, E., "Neue Beitrage zur Kenntniss der Mex. Kreide," p. 10, 1910.

Around Cardenas, which is on the table-land east of San Luis Potosi, overlying the Tamasopa limestones there are highly fossiliferous beds which apparently represent the Eagle Ford, Austin and part of the Taylor, as these formations exist along the Rio Grande southeast of Del Rio.

In the Coastal plain of Mexico, east of the Cordillera, the place of these fossiliferous beds is occupied, as has been stated, by the San Juan and the non-fossiliferous Papagallos, and these two formations stretch northward to the Salado River beyond which we find again the fossiliferous beds of the Upper Cretaceous. They, therefore, in all probability either represent the deeper sea deposition of which the fossiliferous beds were more nearly littoral or indicate the existence of a barrier of some description in this vicinity during the later period of the Upper Cretaceous. The evidence seems to favor the latter condition and that at the close of the Cretaceous this barrier was extended to the southeast by an uplift or uplifts which formed the series of mountain groups and ranges here referred to as the Tamaulipas Range.

On the Rio Grande there appears to be only a slight angular unconformity between the Cretaceous and the Tertiary, but, going southward, we observe that the disturbances at the close of the Cretaceous folded and flexed the limestones and shales so that the contacts from Rodriguez south show very decided unconformities.

CRETACEOUS-TERTIARY CONTACT

The contact between the Cretaceous and the Eocene which, beginning south of San Antonio, Texas, runs a little south of west to the southwestern portion of Uvalde County, makes an abrupt turn at that point and then runs almost due south for more than 250 miles to the Salinas River. From this point it turns southeastward to the Conchos which flows for miles along the southern boundary of the Eocene deposits. The contact between the Cretaceous and the Eocene in Mexico was first found on the Arroyo Caballero, a small creek which empties into the Rio Grande on the Mexican side some three or four miles north of the Maverick-Webb County Line in Texas. From this point the contact runs southwest

to the hills north of Azulejo, where it turns and runs a little east of south, crossing the Salado River near Rodriguez, the Sabinas near Piedras Pintas and the Salinas at Ramones. It was not traced between the Salinas and the Conchos rivers, but it was found on the latter stream near Panalito and traced in a general way southeastward to the Zarzizal. Actual contacts were found in a number of places and the relations determined in others by such proximity of the deposits of the two formations as renders the line here given a fair approximation of the existing conditions.

The upper beds of the Escondido formation are well exposed on the Rio Grande between Las Isletas and the Arroyo Caballero. They consist chiefly of greenish blue shales with calcareous bands overlain by brownish ferruginous sandy clays and sands. The calcareous bands of the lower division carry *Volutomorpha texana* Con., *Buccinopsis parryi* Con., and other gasteropods in large numbers. The overlying sands carry *Sphenodiscus pleurisepta* Con., and large *Turritella*. The following section was made a few yards above the mouth of the Arroyo Caballero:

	Feet.
Alluvial material	4 to 6
Tertiary:	
Yellowish clay	6 to 8
Hard bluish gray sandstone with <i>Ostrea pulaskensis</i> , <i>Turritella</i> , etc.	6
Cretaceous:	
Bluish sand with <i>Sphenodiscus pleurisepta</i>	6
Black hard sandstone.....	2
Laminated blue clay.....	6

Other exposures showing similar contacts were seen in the vicinity.⁴ No evidence was observed of erosion of the Escondido beds before deposition of the Midway, but the beds of the two formations dip at different angles and to the southward the Midway is found in contact with what are seemingly lower horizons of the Escondido and with the

⁴ Note—For details of similar contacts on the Texas side, along the river bluffs and in the uplands, see Stephenson, L. W., "The Cretaceous-Tertiary Contact," U. S. G. S. Prof. Paper 90-J, 1915.

Papagallos shales which are supposed to underlie the Escondido, thus indicating an unconformable overlap.

Amole Creek flows in a long narrow valley in which the Amole Ranch is located. After crossing the creek west of Perros Bravos the country for several miles to the west is covered with the Reynosa, but after passing this, the road crosses a series of small benches made up of thinly bedded yellowish sandstones weathering brown and carrying fragments of oysters. Just west of Amole we found a contact between shaly brown sandstone with abundant *Ostrea cortex* Con. and a somewhat similar sand with *Ostrea pulaskensis* Har. This later sand is overlain in the neighborhood of the Cuevas Ranch by grayish yellow sandy clay and this in turn by the Carrizo sand, which to the south becomes the most prominent member of the Tertiary, overlapping in many places both the Lignitic and Midway to a contact with the Cretaceous. The Cretaceous (Escondido) sandstones noted west of Amole also appear along the western side of the Ceja del Macha and as far south as the Pescado Ranch, underlying a dark brown clay carrying boulders and containing broken and worn fragments of *Ostrea cortex*, which we refer to the Midway. South of the Pescado Ranch we find a large area covered by the deposits of the Reynosa and an old lake bottom, beyond which the first recognizable Cretaceous was encountered in the San Antonio hills. These hills on the eastern side of the Salado River appear to be made up principally of the yellow clays of the Escondido with a plating of gravel.

The Salado River flows in a narrow valley, lying between the San Antonio and San Juan hills, and the sections made here gave us the relations of the various members of the Cretaceous, which are found in contact with the Tertiary. On the west side of the Salado, the San Juan Hills are made up of a series of thin to heavy bedded limestones interstratified with thin beds of yellowish clay. This is the type locality of the San Juan beds. Towards the base the limestones are shaly, dark gray in color, and weather gray to whitish. Toward the summit the limestones are of a bluish shade, weathering white. The uppermost beds are sandy and weather to a reddish or rusty brown color. They

carry numerous impressions of ammonites, oysters, and inocerami, which are of forms referable to the Taylor or Austin horizons of the Texas section. These beds underlie the shales of the eastern side of the river. The greater portion of the Salado Valley is filled with a heavy bed of conglomerate, but from near Santa Rita southeastward to Reparo Creek near Rodriguez, a distance of over 25 miles, there are numerous exposures of heavy beds of greenish-yellow sandy clay, which may be the base of the Escondido, overlying a series of blue clays, blue shales and black shales, with indurated bands. These latter clays are laminated and massive, carry more or less selenite, some calcite and barite, and in places boulders of a yellowish brown hard flinty sandstone. No fossils were found in them, but they are the direct stratigraphic continuation of the beds we have called Papagallos. These rest upon the San Juan beds.

The Escondido with *Ostrea cortex* appears on Camaron Creek about midway between the San Antonio Hills and Ceja Madre and in the western slope of the Ceja Madre we find the brown and blue shaly clay and marls of the Midway with *Venericardia alticostata*, etc.

Reparo Creek joins the Salado River just west of Rodriguez. Half a mile above the junction of the streams, we have a section showing a contact in which the yellowish brown shaly clay of the Wilcox rests on the blue Papagallos shales of the Cretaceous, while further up the creek we find the fine-grained brown and gray sandstones of the Carrizo in contact with the Cretaceous shales at several places. This indicates the transgression of both the Wilcox and the Carrizo over the Midway in this locality. From Rodriguez the outcrop of the blue shale continues down the west side of the Salado River to within a few miles of San Jose and then turns southward, crossing the Sabinas west of Piedras Pintas. At Vallecillo we have the San Juan limestones with Inocerami followed to the east by the Papagallos shale and this by the Midway (?) at Piedras Pintas. From here the line of contact runs south to a point three miles east of Cerralvo where there is a range of hills with eastward facing scarp and north-east dip. They have a height of 200 feet and are made up of the blue and yellow shales of the Papagallos which show

in them, here and there, massive blue nodules or boulders which weather white. To the east of these hills lies a valley two miles wide, and the hills which form its eastern margin are composed of the sands and clays of the Midway.

The Papagallos Mountains lying west of Ramones rise somewhat abruptly from the river and at the distance of a mile attain an elevation of 800 feet. So far as can be seen, the range is made up of highly metamorphosed blue shales, which weather white on exposure and which have been folded into a sharp anticlinal, the dip of which on its eastern slope is as much as 60 degrees, while the dips on the west vary from 30 to 70. The entire valley to the west seems underlain by the same shales but with greatly lessened dips, and these form small hills at Ayancual and elsewhere. These shales also stretch to the east and exposures on the river show that they were considerably disturbed and crumpled prior to the deposition of the Eocene beds. These beds were not traced between the Pesqueria and the Conchos, the line of travel lying east of them and over the Tertiary deposits.

On the Conchos River the conditions appear to be similar to those on the Salinas and the only exposures of the Papagallos shales seen were in the river below the Tertiary beds. The main body of the Cretaceous deposits lies west of Vaqueria. They then swing eastward around Burgos Peak, southeast of which the San Juan limestone is found in a canyon. From this locality several poor specimens of ammonites, including a *Mortoniceras* (?), sp. were collected, of which Dr. T. W. Stanton says: "The genus *Mortoniceras* occurs in the San Carlos beds, in the Austin chalk, and in the Tombigbee sand. If correctly identified, the presence of this genus probably means the limestone is not younger than the Taylor marl and may not be younger than the Austin chalk." To the southeast of this on the road to Cruillas the blue shales come in again. Northwest of Abasolo the San Juan limestones appear, while Abasolo itself is on the blue Papagallos shales and these extend southward along the river as far as Soto la Marina, at which place they are also found in wells. In this region they are overlain in places by the yellow clays of the San Fernando and by the Coquina limestone and the Reynosa.

Between Soto la Marina and San Rafael the only contacts observed were between the San Fernando and the eruptives lying east of the Tamaulipas Range.

THE TERTIARIES

Our examination of the deposits occurring along the Rio Grande and overlying the Escondido failed to show any beds of the Eocene of later age than the Frio substage of the Claiborne. This was followed directly by our Oakville or upper Miocene. No Oligocene or lower Miocene are present there, so far as our present knowledge serves.

The formations recognized are: ^{5, 6, 7, 8}

Claiborne:	{	Frio Fayette Yegua Marine Carrizo
Wilcox,		
Midway.		

Between the Rio Grande and the Conchos, however, we find the Oligocene coming in between the Frio and overlying materials and to the south it attains a strong development.

Briefly stated, the characteristics of the several divisions of the Eocene as known on the Rio Grande are as follows:

MIDWAY

Gray clays with limestone concretions overlain by bluish shales and shaly sandstone interstratified with ferruginous sandstone, both series carrying *Venericardia alticostata*, *V. planicosta*, *Ostrea pulaskensis*, *Cucullæa macrodonta* and other forms.

WILCOX

A lower series consisting of blue and gray sandy shales, light gray sandstones and bluish, carbonaceous, sandy shale

⁵ Dumble, E. T., "The Cenozoic Deposits of Texas," Jour. Geology.

⁶ Vaughan, T. W., Reconnaissance of the Rio Grande Coal Fields of Texas, U. S. G. S., Bull. 164, 1900.

⁷ Dumble, E. T., "Geology of Southwestern Texas," Trans. Am. Inst. Min. Eng., 1902.

⁸ Dumble, E. T., The Carrizo Sands, Trans. Tex. Acad. Sci., 1911.

with sulphur which is overlain by a second series, comprising black, lignitic, sandy shales with concretions or boulders of gray carbonate of iron, weathering red, lignitic deposits, etc. Fragments of *Cardita*, etc.

CLAIBORNE

The Claiborne, as a whole, comprises several alternations of deposits of clays and sands, and for purposes of description and mapping, is divided into substages.

Carrizo Sands

Sandstones of varying color, texture and thickness. The prevailing color is a grayish yellow, weathering light brown. Some of the beds are white when freshly broken. In texture they range from fairly hard sandstone, lying in beds of two to four feet or more in thickness, to thin slabby, fairly soft, and almost shaly structure. No fossils except a few plant remains have been found in them.

Marine Beds

Greenish clays and lignitic sands with palmetto and other plant remains, and some lignite, overlain by carbonaceous clays and sands with gypsum and particles of lignite, capped by brown or buff sandstone. These beds are not so glauconitic on the Rio Grande as they are in eastern Texas. This substage usually carries an abundant and characteristic fauna, including such forms as *Venericardia planicosta* Lam., *Anomia ephippioides* Gabb, *Ostrea divaricata*, *Nassa texana* Gabb, *Distortix septemdentata* Gabb.

Yegua

At the base, interbedded brown sands, chocolate clays with green sand, and lenticular masses of red sandstone; then buff and greenish sands slightly calcareous with occasional bands of limestones, gypsum and cannon-ball concretions abundant. Buff sandstone overlain by blue and green ferruginous clays with calcareous concretions followed by yellow sandy clay form the upper portion of the measures. In places the concretions in these beds carry aragonite and chalcedony. While not fossiliferous throughout, the beds carry a typical Claiborne fauna and are characterized by *Tellina mooreana* Gabb, var., *Turritella houstonia* Har., *Natica recurva* Aldrich.

Fayette

Buff sandstone with greenish, sandy clay, lignitic clays with concretions and some lignite, opalized wood and chalcidony. Fossils are abundant in these beds along the Rio Grande; the most characteristic being *Ostrea alabamiensis contracta*, *Cornulina armigera heilpriniana* Har., *Cerithium pliciferum* Heilp.

Frio

Gypseous clays with sands. Clays gray and green in color, often weathering white and containing leaf impressions and ferruginous and calcareous concretions. The fossils, which are not numerous, are oysters of smaller size than those of the Fayette, *Corbula*, etc.

AREAL DISTRIBUTION OF THE TERTIARIES

MIDWAY AND WILCOX

While there are numerous localities at which it is possible to distinguish the various stages of the Eocene, by their several lithologic and faunal characteristics, it will require more detailed work to show the exact areal distribution of the lower members. This is due to general similarity of materials, scarcity of distinguishing fossils at many places, the successive overlapping of the upper members upon the lower, and the widespread occurrence of the Reynosa, which covers them over many square miles. This applies especially to the Midway and Wilcox, and to the Carrizo Sands of the Claiborne. For this article, therefore, the area occupied by the deposits of these stages will be treated as a unit, noting the various occurrences of each where identified, but leaving the area as a whole undifferentiated. The area has for its western boundary, along which we may find any or all of these deposits, the Cretaceous-Tertiary contact just described. Its eastern border, which is the line of contact of the Marine substage with the Carrizo Sands, crosses the Rio Grande just south of the mouth of Espado Creek and, running south-eastward by Hidalgo, crosses the International Railroad near Jarita, 16 miles west of Laredo, and the Salado at Los Moros, 10 miles west of Guerrero. It then takes a southerly

course to its crossing of the railroad and Pesqueria River, a short distance west of Herreras, and then southeastward again to near Vaqueria on the Conchos, which is near its southernmost exposure.

Along the Rio Grande the Midway with its fossiliferous beds is fairly persistent for some distance and forms the base of the hills to a point a mile or more south of the mouth of Penitas Creek. But it is not often the surface rock, as it is usually covered by the Wilcox or Carrizo.

The Wilcox appears only in limited areas, having probably been subjected to erosion before the deposition of the Carrizo and while it occasionally appears on this river between the Midway and Carrizo, there are many exposures in which it is lacking and the Carrizo rests directly upon the Midway. This is well shown in the Cerrita Prieta and the hills to the south.

South of the river the brown, fossiliferous sandstone of the Midway is well exposed for several miles and it is seen again at a crossing of Amole Creek nine miles southwest of Perros Bravos.

On Amole Creek the Wilcox appears below the Carrizo in places, while at others the Carrizo Sands rest directly upon the Midway or even on the Escondido beds.

West of Amole Creek the Midway sandstone is underlain by shaly sandstones with small oysters, and these are underlain by the Escondido beds with *Ostrea cortex*. Along the western side of the Ceja del Pescado, a low range of hills, lying south of Azulejo, there appears a series of shales and sandstones weathering to a dark brown, clayey soil carrying the distinctive boulders of the Midway, and broken fragments of *Ostrea cortex* as found at base of the Midway elsewhere. This range of hills stretches southward for some miles.

The Carrizo, as has been stated, has a very wide extension in the northern part of the area and forms the top and eastern slope of the various small groups and ranges of hills north of the Arroyo Agua Verde and of the longer range known as the Ceja del Macha and Ceja Madre, which extends from Azulejo nearly to the Salado River.

South of the Salado, the conditions seem to be different

from those in the territory nearer the Rio Grande. The Carrizo is less dominant, in fact between the Salado and the Pesqueria and along the railroad we observed no beds certainly referable to the Carrizo, although it doubtless occurs. While the exposures of the Wilcox are still limited, the Midway shows much greater development.

On the road from Mier to Cerralvo, we find $2\frac{1}{2}$ miles west of La Masa, a range of hills trending northwest and southeast and having a northeast dip. The section shows:

	Feet.
Sandstone	8
Yellowish clay	10
Fine-grained, smooth, yellow sandstone.....	10
Blue clays weathering yellow.....	20
Alternating clays and sandstones in thin beds.	

The character of these beds and their stratigraphic position warrant their reference to the Midway. They occur again at a creek crossing 10 miles south of Cerralvo on the Herreras road and a hill in this vicinity is capped with fossiliferous sandstone showing Midway forms. They also have a wide development in the valley of the Pesqueria River between Ramones and Herreras.

A hill north of La Masa gives us a section of the Wilcox clays overlain by the Carrizo, and similar beds were observed southeast of Cerralvo.

The town of Ramones is located on the blue shale of the Papagallos and exposures are seen in the river bed for two or three miles east of the town, underlying the yellow clays of the Midway and the calcareous conglomerate of the Reynosa.

A quarry $2\frac{1}{2}$ miles north of Ramones gives the following section:

	Feet.
Thin soil	1
Thin bed of ferruginous sandstone containing <i>Venericardia alticostata</i> , <i>Ostrea pulaskensis</i> , etc.	1 to $1\frac{1}{2}$
Thinly laminated shale, gray and black.....	4 to 12
Soft gray sandstone.....	10

Another quarry to the south of this, on the ridge dividing the river and Ayancual Creek, shows the same limestone with the same fossils and they are seen again at the head of an old irrigation ditch near Hacienda Nueva, five miles west of Herreras. North of the river the Midway includes a series of interstratified blue and brown, shaly clay and gray, brown or white sandstones which extend for several miles and find in the Alto Colorado their most conspicuous development. This hill is three miles north of kilometer 1121 on the railroad. It shows the following section:

	Feet.
Brownish gray, heavy bedded sandstone.....	3
Limestone, fossiliferous	1
Brownish sandstone	8
Blue clay, weathering yellow.....	3
Yellow brown sandstone, somewhat calcareous, fossiliferous	160
Yellow, shaly clay	80

The fossils are not very well preserved, but include *Ostrea pulaskensis*, *O. crenulimarginata*, *Venericardia planicosta*, *V. alticostata*, *Turritella*, and other undetermined gasteropods. The same beds were also observed 16 miles southeast of Ramones on the road to China, which was the most southerly exposure of them which we could identify.

A mile southeast of Comitas, on the road from Ramones to China, there is an exposure of typical Wilcox strata but without any fossils. It consists of heavy beds of clay with nodules of clay ironstone, weathering red.

CLAIBORNE

Carrizo

South of the Pesqueria, sandstones, probably referable to Carrizo, were seen $2\frac{1}{2}$ miles west of San Juan and there was also seen a gray sandstone with westerly dip a few miles north of Vaqueria, which may represent it. The greatest development of these sands, however, both in Texas and Mexico, is found in the drainage area of the Rio Grande.

Marine

The beds belonging to the Marine substage of the Claiborne, as seen on the Rio Grande, have a wide development, the river flowing through them from the mouth of Espado Creek to a point eight miles south of Laredo, a total distance of 50 miles, but this is at an angle to the dip of the beds. They narrow rapidly to the south and where they cross the Salado River west of Guerrero, their outcrop is not more than five or six miles wide. East of Cerralvo, they occupy the area between La Masa and the General Trevino Ranch.

Like the Midway, the Marine beds are well developed in the valley of the Salinas. Indeed, the valley of the San Juan, of which the Salinas is a part, gives by far the most complete and satisfactory section of the Atlantic coast type of Eocene deposits which we have so far found in Mexico. Two miles north of Herreras, there is a hill 170 feet in height, known as Loma Larga, with an escarpment facing west and south, the beds of which have a southeast dip. The section is:

	Feet.
Reynosa limestone	4
White clay with small concretions.....	6
Yellow clay with interbedded micaceous sandstone	30
Greenish sandy clay.....	10
Blue shale and clay with septaria.....	120

The fossils identified from this locality include *Venericardia planicosta* *V. potopacoensis*⁶ and others. An exposure on the railroad half a mile east of Herreras shows similar beds with numerous fossils belonging to the Marine stage. This section was repeated in an exposure on the river south of the railroad. A mile east of Herreras, a long shallow cutting on the railroad shows a section of gray yellow clay and thin calcareous sandstone. Here were found quantities of well preserved fossils, consisting principally of *Venericardia planicosta* and *V. potopacoensis*. The position and dip of these beds would place them at the base of, or below, the

⁶ This form is well known in the Maryland Tertiaries but has not been found previously in the Gulf Tertiaries.

beds exposed in the Loma Larga. East of this cutting we found gray sandstones and shales and brown, ferruginous sandstones which extend east within a mile of La Laja. Among the fossils found in them were *Ostrea alabamiensis*, *O. sellæformis*, *Venericardia planicosta*, *Pyrula*, sp. (?), *Cassidaria*, sp. (?) and many smaller forms. Continuing south of the Pesqueria, there is found three miles southeast of Comitas a succession of low ridges caused by the upturned edges of sandstones of this age with an abundant fauna, which, however, is very firmly embedded in the calcareous sands. On the San Juan River west of China and between Barranca and San Juan, the Marine beds of clays and sands with *Ostrea alabamiensis* are found. The road from San Juan to Vaqueria shows many exposures of these beds. A hill half a mile west of La Ciga gives, at its base, a good section of the clays and sands with *Venericardia potopacoensis* and other forms. At Jaboncillos Ranch, 20 miles south of San Juan, a calcareous band was found, composed largely of *Venericardia potopacoensis* and this stratum was followed for 10 miles in a southeasterly direction toward the Conchos. It dips N. E. 10°. While no fossils were found which positively identified them as Marine, it is probable that the yellow clays and sands along the river east of Vaqueria belong to this substage.

Yegua

The beds belonging to the Yegua substage form the surface rocks on the Rio Grande from eight miles south of Laredo nearly to the mouth of the Salado River. Their eastern border in this area is found west of Guerrero on the Salado and extending southward, crossing the road from Mier to Monterey, a short distance east of the Borregas Ranch; the Brownsville-Monterey railroad, 6 miles east of La Laja; the San Juan River just west of China, and the Conchos west of Mendez. Its fossils are principally oysters and are usually poorly preserved. They are probably *Ostrea alabamiensis*. At the foot of a hill a short distance east of Borregas Ranch, there is an exposure of beds of purple sandstones and clays, one of which is composed almost entirely of the cannon-ball concretions of the Yegua. From these beds we collected the

following fossils: *Venericardia planicosta*, *Volutilithes petrosa*, *Pseudoluva vetusta*, *Natica recurva*, *Harpa*, sp., *Pecten*, sp., etc. At the top of the hill are the Fayette sands with *Ostrea contracta*. Southwest of Borregas the road passes hills of reddish and purplish sandstone and yellowish sandy clays which are also red in places. These beds have a north-east dip and are visible until the San Domingo Ranch is reached, 6 miles west of Borregas. Beyond this the country is level with no exposures for several miles until we find a hill which shows the purple sands of the Yegua underlain by the gray and yellow sandy clays of the Marine. Near La Laja, which is on the railway near the Salinas River, the Yegua occurs as heavy bedded gray, bluish gray, and red sandstone with blue, brownish yellow and red clay shales, followed by thinly stratified gray clays and sandstones. The only fossils found were fragments of oysters. Half a mile west of La Ciga, a small hill showing Marine strata at its base seems to be capped with Yegua, a few fossils, including *Natica recurva*, indicating that age. East of La Ciga the chocolate sandstones and clays with cannon-ball concretions are exposed in a low ridge for several miles. The Yegua continues to the Loma ford on the San Juan River, two or three miles west of China. On the Conchos River, one mile east of Angeles, where a large creek enters the river from the south, there is a bluff some 75 feet in height with 25 feet of purple lignitic shale at base, capped by yellow clays with shaly sandstones and beds with nodules of carbonate iron weathering red. This is typical Yegua. The latest beds of Yegua seen were east of Sonada, where there are exposures of blue and yellowish clays with gypsum, interbedded with beds of sandstone four inches to two feet in thickness. Beds of brown clays in a hill one mile west of Mendez mark the top of its development here. No fossils were found here, but its lithologic character and stratigraphic position warrant the reference.

Fayette

The Fayette, like the Carrizo, is predominantly sandy. Like the Carrizo also, the Fayette, at times, overlaps the lower substages of the Eocene. Its exposure on the Rio Grande is fully equal to that of the Marine, stretching from

just north of the junction of the Salado and Rio Grande almost to the mouth of the San Juan. On the Rio Grande it carries many fossils connecting it directly with the Claiborne, together with others distinctively its own, the most prominent of which is the large oyster, *Ostrea alabamiensis contracta* Conrad; by which we have identified it as far south as the Conchos.

The town of Mier is on the Fayette sands, which here have a northeast dip. They are well shown in places along the road from Mier to Camargo and on the river. The upper beds are a series of yellow sands and greenish yellow clays with gypsum, overlying yellow sandy clay with *Ostrea contracta*, and sandstone beds alternating with yellow clays. Going southwest from Mier we pass over the same beds, until near Borregas at the edge of a scarp facing northwest, we find the lowest Fayette with *Ostrea contracta*. This is underlain at the bottom of the hill by Yegua. About a mile north of Borregas Ranch an outlying hill shows the Fayette as yellowish sand and pinkish sands and clays with leaf impressions. The section is:

	Feet.
Yellow sandstone, <i>Ostrea contracta</i>	3
Yellowish and purple clay.....	20
Clayey limestone, fossiliferous.....	1
Yellow and pinkish clays.....	10
Yellow sandstone, leaf impressions.....	3

These beds dip N. E. On the Matamoras-Monterey railroad the Fayette sands begin six miles east of La Laja. The exposures show light gray, almost white, sandstone ranging from two to four feet in thickness, quartzitic in places, and interbedded with softer sands and clays. West of Los Alamos is a bluff of sandstone with oysters. The top weathers very rough. The Fayette beds have a northeast dip and extend along the railroad some five miles or more east of the river. In the bank of the San Juan River north of China, these sandstones and clays make their appearance and the road from China to Chilarios shows them as a series of gray sandstones and clays, some of the sandstones being concretionary and some thin-bedded and ripple marked. Near

Chilarios the oyster beds are found with fragments of *Ostrea contracta*. The development of the Fayette sands in the vicinity of the Conchos River is quite extensive. They form the western flank of the Sierra de Pomaranes and the continuation of these hills to the south and west of the river, overlapping the lower beds of the Tertiary to a contact with the Cretaceous (San Juan) limestones east of Burgos Peak. It is only the erosion of the river which has brought to light the few exposures of the lower beds of the Eocene, which we have described as in its basin. The upper beds of the Fayette which cross the river at and east of San Diego and the San Pedro Ranch, are composed of massive rough weathering sandstone with a few large oysters. These extend up the river valley to within a mile of Mendez, where they rest on the Yegua. They appear west of this in a hill near Piedras. As nearly as we can determine, they form the plateau north of the river. The same beds are seen forming the plateau southward toward Burgos; on a creek west of Burgos, dipping west at high angle and overlain by Equus beds; and are found again three miles east of Burgos. They also form the body of Mt. Corcovada, where they show a westerly dip. The road from Burgos to Cruillas has few exposures and these only of yellow clays, but between Cruillas and Choreras the gray sandstone of the Fayette occurs in a hill, and it is found lying in low ridges a few miles southwest of Choreras. This is the last exposure we are able to identify as Eocene in this area.

To the west the Cretaceous limestones and shales come in and continue down the Soto la Marina to Abasolo, while from Choreras southward, the San Fernando practically covers all the lower beds and rests directly upon the Cretaceous.

Frio

On the Rio Grande the Frio beds are found capping the Fayette just south of Roma and disappearing under the Oakville below Rio Grande City. They form the surface rocks, where the Reynosa is absent, in the valley and to the north of the San Juan River for 30 miles or more southwest of Camargo.

South of the Salinas River on the road from China to Laguna de los Indios we find, beginning a mile west of Chilarios, a series of yellow clays with nodules of red clay, ironstone and gypsum, which apparently belong to the Frio. Southeast of Chilarios all the washes and gullies show the yellow gypseous clays with only a few shaly sandstone beds. These carry the small oyster of the Frio. Just how far these beds extend to the southeast before they are covered by the yellow sandy clays of the Oligocene, could not be determined owing to lack of suitable exposures. Similar clays were, however, observed 24 miles southeast of Chilarios. The best development of these beds was found in the region of the Conchos River. Between Tepetate and the San Francisco Ranch, northwest of San Fernando, they comprise yellow clays and soft gray sandstones, dipping northeast and carrying oysters. The hills stretching northwest from this locality are largely made up of these clays and sands with beds of gypsum and in the Sierra de Pomeranes they also show a considerable thickness and are interbedded with or carry gypsum in all its varieties. Here they are underlain by the Fayette and capped by the San Fernando. At San Diego, which is at the southern point of these hills, the Frio shows in a ridge capped with three feet of massive gypsum underlain by greenish clays weathering white and carrying the Frio oysters. Their extension south of the Conchos, if any, has not yet been worked out.

So far as our investigations show, all exposures of Lower Eocene (Midway and Wilcox) deposits are confined to the limits of the present drainage basin of the Rio Grande. Whether this coincides with the limits of the Rio Grande embayment of Lower Eocene time cannot be stated. The deposits of the Middle Eocene, however, extend south through the basin of the Conchos River.

From the evidence before us it appears that following the close of the Wilcox deposition there was a period of elevation and erosion, succeeded at the beginning of the Lower Claiborne by a rather rapid incursion of the sea which transgressed the earlier Tertiary area in places and allowed the deposition of the Carrizo sands. During the succeeding sub-stages of the Lower Claiborne there was a gradual sinking

of the eastern face of the Tamaulipas Range, permitting the later deposits to overlap the earlier, and its close was marked by gradual dessication and the formation of the numerous beds of gypsum found in the Frio clays. Here, as in Texas, no beds have been recognized which are in any way referable to the Upper Claiborne.

UPPER EOCENE

Between the exposures of the Frio on the Rio Grande and southward and the first deposits clearly referable to the Oligocene there is quite a belt of country, largely covered by the Reynosa. It is entirely possible that within its limits there may exist representatives of the Upper Eocene or Jackson such as occur in eastern Texas, but which are apparently entirely wanting in the valley of the Rio Grande. The only deposits actually observed that seem in any way related to this period were found overlying the Frio on the road from China to Laguna de los Indios. The Frio clays and soft shaly sandstones formed the country rock from Chilarios southeastward for some distance. No change in character of deposits were seen for 24 miles, but at a so-called Mina Antigua some three miles southeast of Rancheria, the old shaft, 20 feet deep with tunnel to east of 40 feet, showed principally sands. The tunnel was in a bed of coarse-grained bluish sand carrying pyrite, gypsum, and sulphur and entirely different from any Frio materials. From this point to Laguna de los Indios, some 18 miles, the surface is sandy. The well at the ranch is 80 feet in depth, the materials through which it was sunk being coarse-grained bluish sand with gypsum similar to that found at the old mine. The sand was here interbedded with yellow clay which carried a number of poorly preserved fossils. Dr. W. H. Dall, who looked them over, stated that they contained a *Pecten* recalling *P. poulsoni*, *Tellina* and *Cardium* or *Venericardia*, which, while not characteristic, seemed to indicate an Upper Eocene or Oligocene horizon. This may prove to be the southern extension of the Jackson of east Texas. Similar sands covered by the Reynosa occur also in ridges northwest of the ranch.

OLIGOCENE

Overlying the beds we have here referred to the Eocene, we find a series of yellow sands, clays and calcareous beds which carry an Oligocene fauna. We have called these the San Fernando from the fine exposures of the beds in the vicinity of the town of that name on the Conchos River. As will appear, these beds all belong to the Upper Oligocene and up to this time no beds of the Lower Oligocene, like those of the Buenavista River region with *Orbitoides papyracea*, etc., have been recognized in the area north of the Tamaulipas Range. From our present knowledge it would seem that while the Lower Eocene deposits show a gradual overlapping southward until the Conchos is reached, the Oligocene, on the contrary, shows an overlapping northward to the same region, so that along the Conchos the uppermost beds of the Oligocene are in contact with the members of the Eocene there exposed.

In the region of San Jose de las Rusias,⁷ which occupies the extreme southern portion of this area, we have numerous exposures of the Upper Oligocene. It apparently immediately overlies the Cretaceous and is penetrated by eruptive rocks which are connected with or extend eastward from the Tamaulipas Range. In places these eruptives are of a porphyritic texture but at others they are basalts. They occur as masses, ridges or isolated peaks throughout the region and the Oligocene beds in immediate contact with them are more or less metamorphosed and show at times considerable dips. These eruptive rocks, in places, extend to within two or three miles of the Gulf coast.

The lower beds of the Oligocene in this region are yellow clays, which are altered in places and appear as hardened shales, and clayey limestones carrying *Cristellaria*, *Nummulites*, corals and molluscan forms followed by yellow sands and clays with an extensive fauna. The beds have a general southeast dip. At San Rafael on the Zarzizal River at the extreme southern end of the district, the contact of the eruptives with the yellow clays is well shown.

Northward of San Rafael toward the ranch of San Jose de las Rusias, the principal exposures are of eruptive rocks,

⁷ An excellent description of this region will be found in "Boletin del Instituto Geologico de Mexico," No. 26, Juan D. Villarello.

porphyries and basalts, with occasional outcrops of the hardened shale and the yellow clays of the Oligocene.

Lying four to six miles east of San Rafael there is a range of hills 300 to 400 feet in height, composed of alternating beds of yellow clays and clayey limestones carrying poorly preserved molluscan forms together with great numbers of *Cristellaria*, corals, and some *Nummulites*. Among the corals collected here, Dr. T. W. Vaughan determined *Favosites* (?) *polygonalis* Duncan, *Goniastrea antiguensis* Duncan, *Acropora* (?) sp., *Orbicella*, n. sp., and *Goniopora*, sp., very similar to or identical with an Antigua species. These, he says, indicate an Upper Oligocene horizon about equivalent to the Chatahoochee of Georgia.

To the east of this range stretches an open prairie country in which there is a ridge of eruptive material (basalt) which runs parallel with the range of hills and has a width of five miles. To the east of this eruptive ridge and only two miles from the Gulf shore a sandstone was found very similar in character to those of the Pecten bed on the Conchos and carrying the same Pectens.

Around the San Jose de las Rusias Ranch the beds which are exposed show considerable disturbance. Immediately at the ranch the beds, which are fossiliferous sandstones, dip northwest at a high angle. Northeast of the ranch a hill 60 feet high shows beds of yellow clay overlain by hard calcareous sandstone which weathers into rounded masses. A great number of corals occur within the clays and in the sandstone. Dr. Vaughan reports *Orbicella cellulosa* Duncan, and *Mcandrina*, n. sp. from this locality. A short distance north of this hill is another in which the basalt has come up through the Oligocene beds which are here impregnated with asphalt. To the east of the ranch, some few miles, there is a range of hills 400 feet high capped with the Coquina, and lying to the east of the range another volcanic hill. North of the Soto la Marina the same clays and limestones occur and east of the Salitre Ranch, the same *Orbicella* was found as that occurring southeast of San Rafael, together with specimens of a new genus of the fungid corals. At and around Salitre were found three species of echinoderms, the

only ones so far found in beds we have recognized as Oligocene. The following is a section of the deposits near Salitre:

	Feet.
Coarse gray sandstone.....	20
Yellow clay, fossiliferous.....	100
Hard yellow clayey limestone, fossiliferous.....	4
Yellow sandy clay	10
Yellow sandstone, fossiliferous	8
Yellow clays and sands	10

A range of hills known as the Martines which are similar to those seen east of San Jose de las Rusias and of about equal height is found here extending from Salitre southward nearly to the Soto la Marina River. Along the Conchos River the exposures of the Oligocene are of beds higher in the series than the bulk of those of San Jose de las Rusias, being represented in that region by the Pecten beds which lie along its extreme eastern border. In the valley of the Conchos the greenish clays and soft sands with their beds of gypsum, which are part of the Frio, are found as far east as Tepetate and forming the body of the hills lying directly north. Beds of the Oligocene are found not only overlying these beds at this point, but stretching several miles westward, showing a clear overlap to lower beds of the Eocene section.

What seem to be the lowest beds of the San Fernando section were found three miles west of that town, and consist of cross-bedded gray sandstones with a thickness of 60 feet. Half a mile east the beds form a series of falls in the river and we have the following section:

	Feet.
Conglomerate	4
Cross-bedded sandstone indurated and with bands of fossils	70
Yellowish sandstones with fossils.....	3
Gray sandstones, weathering in holes, few fossils	4

The cross-bedded sandstone carries a great number of a large Pecten, which are well preserved and, as it appears to be a well marked horizon, we have called it the Pecten bed. It is immediately overlain by beds of sandy clay with fragments

of shells, a well preserved large gasteropod, and numerous claws of a crustacean. These beds continue down the river. A bluff opposite San Fernando shows:

	Feet.
Reynosa	20
Yellow clay	20
Yellow sandy clay with many fossils.....	4
Cross-bedded sandstone	30

The river here runs, south almost with the strike of the beds; thus the same or similar beds are seen for three or four miles down-stream, when the river again swings east. Here the clayey sands seen at the falls above the Pecten bed carry not only the large gasteropod and crustacean claws, but graminite and fragments of lignite also. Hills a mile east of this locality are composed of soft yellowish sandstone and clay beds with a Coquina limestone on top. Still south of this a section one-half mile east of Algodones shows heavy beds of yellow sandy clay overlain by yellow clay containing casts of fossils and many valves of Pecten. This was followed by another bed of yellow clay and this by a series of calcareous sands and silicious gravel 20 feet thick with numerous casts of a Cardita-like shell and single valves of large oysters which appear to have been transported. The same beds are also found in the hill one mile north of Algodones and extending two miles or more to the eastward. These Oligocene sands and clays also form the body of the hills north of San Rafael, on the Conchos, and the eastern flank of the Pomeranes. To the north and east of this locality their extension is largely hidden by the Reynosa covering.

NEOCENE

Coquina Limestone

Overlying these fossiliferous sands and sandy clays of the upper San Fernando, which seem to have a thickness of 300 feet or over, we find a bed of Coquina limestone, or possibly a succession of such beds. Half a mile east of the bluff near San Fernando, the Coquina limestone was found overlying the beds of the section as already given, and similar Coquina is found near San Diego, capping a small hill and occupying

the valley of the river for two miles to the southeast. This is more than 20 miles west of the exposure of any beds we have so far recognized as Oligocene. The Coquina was also seen west of Chorreras, where it apparently rests upon the Fayette and between Abasolo and Soto la Marina in contact with the Cretaceous. In the San Jose de las Rusias region it was also observed in several places forming the tops of the hills. It is probably of Neocene age.

Reynosa

The eastern border of the outcrop of the Reynosa limestone was traced by Professor Cummins from Reynosa southward to the Conchos River in the vicinity of Rinconada. From this border the Reynosa spreads westward covering more or less of the area underlain by the Tertiaries here described, and in places extends to the foot of the Sierra Madre. One of the best exposures seen was at Abasolo in the Soto la Marina River, where the Reynosa (overlying 60 feet of blue Papagallos shale) shows 40 feet of a conglomerate of blue limestone pebbles overlain by 60 feet of tuffaceous limestone. Many good sections of it were secured from the logs of water wells in the area. At several places small basins were found in it, in which deposits of *Equus* bed material and fossils occur as they do around San Diego, in Duval County, Texas.